Bacteria TMDL Development for the Rappahannock River Basin

TAC Meeting #3

November 13, 2007

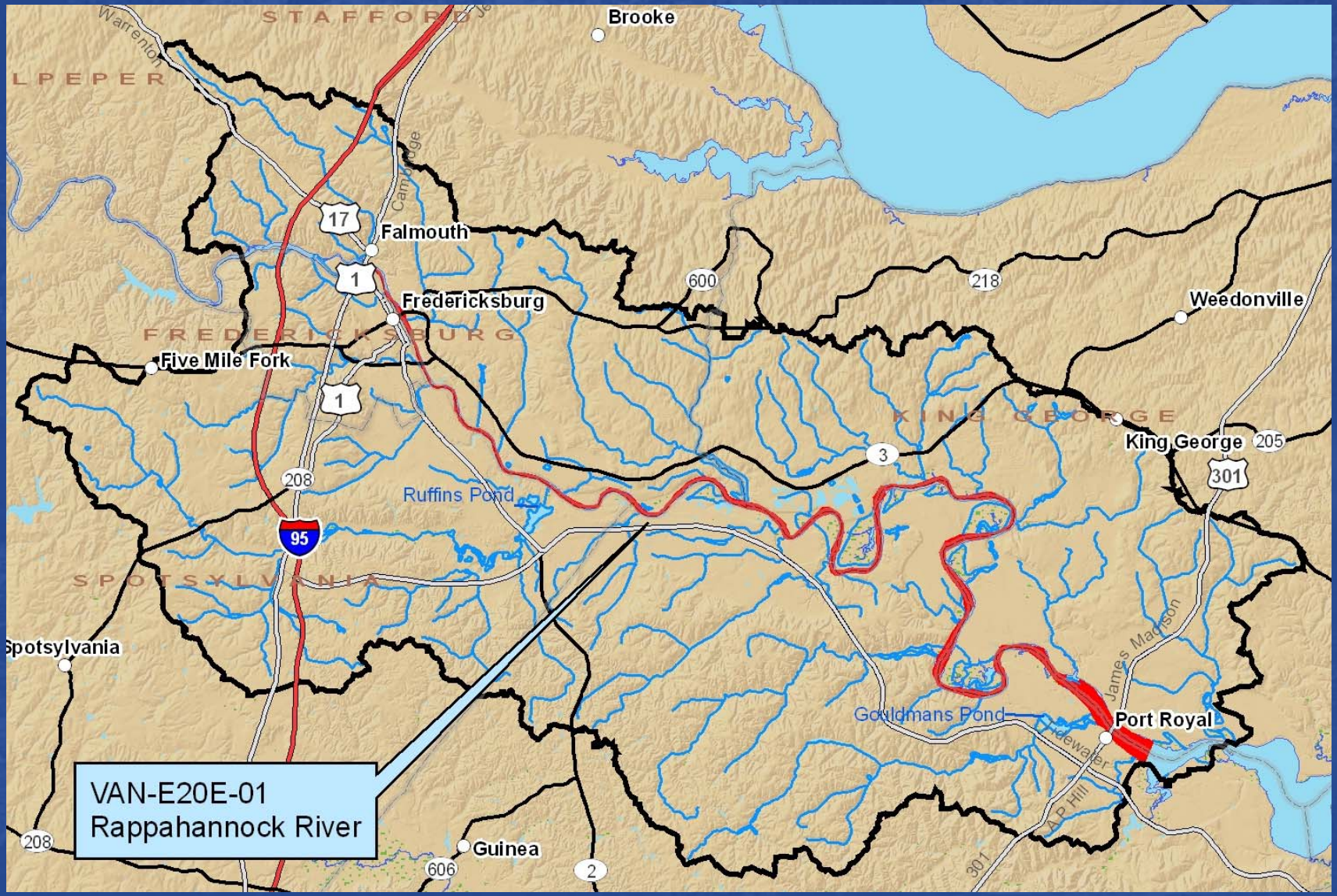
The University of Mary Washington

THE Louis Berger Group, INC.

Agenda

- **Recap of TAC Meeting #2**
  - Discussed Land Use Reclassification
  - Presented the Sources Assessment
  - Presented Technical Approach
- **Present Hydrology Calibration**
- **Present Hydrodynamic Calibration**
- **Present Water Quality Calibration(s)**
- **Present Fecal Coliform Load Distribution**
- **Present and Discuss Allocation Scenario Results**

Bacteria Impairment



Modeling Strategy

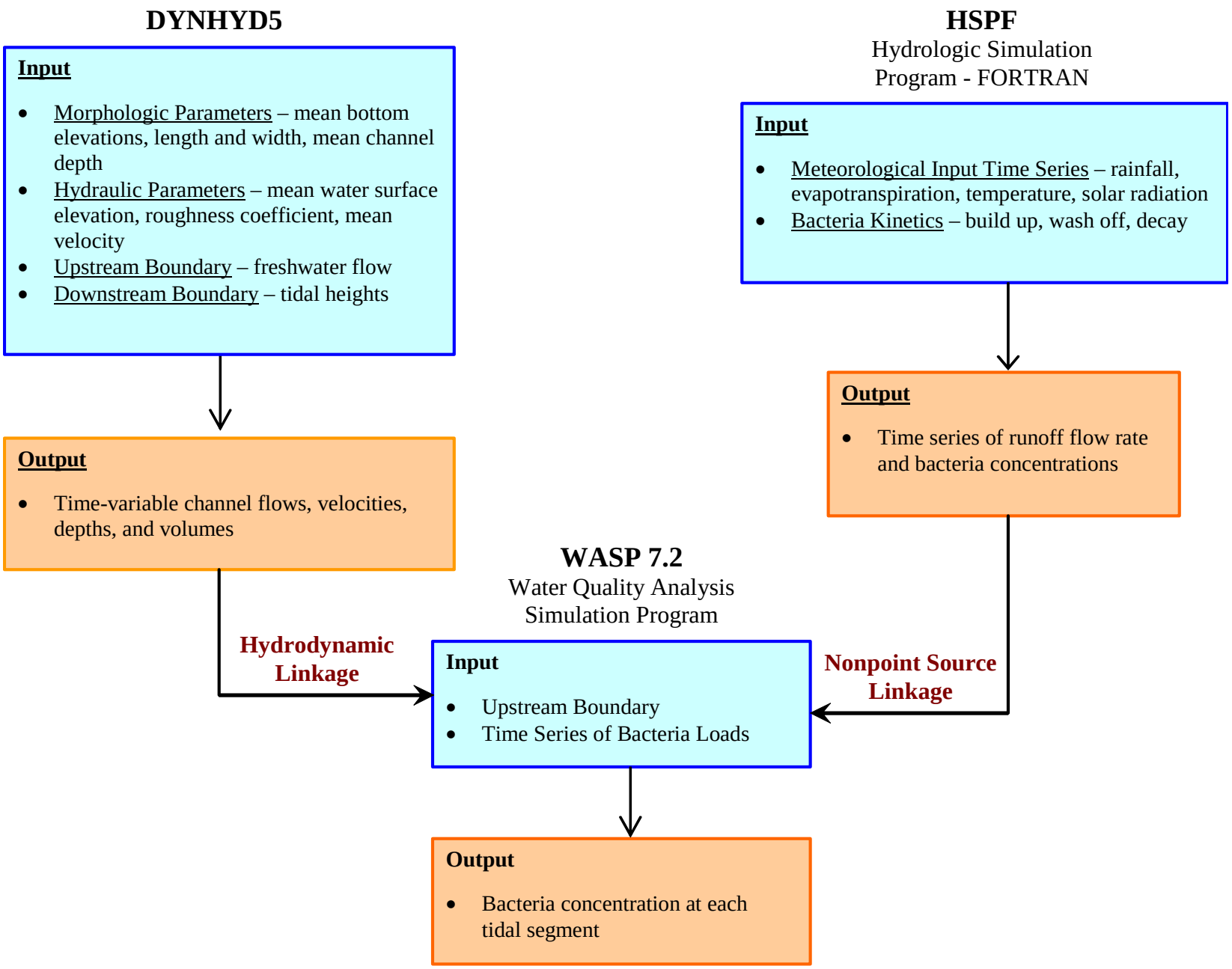
The following approach was approved by DEQ and EPA on August 16, 2007

Watershed Model

- HSPF
  - Hydrologic Simulation Program FORTRAN (HSPF) model (Bicknell et al., 2001) to simulate watershed loading processes

Instream Model

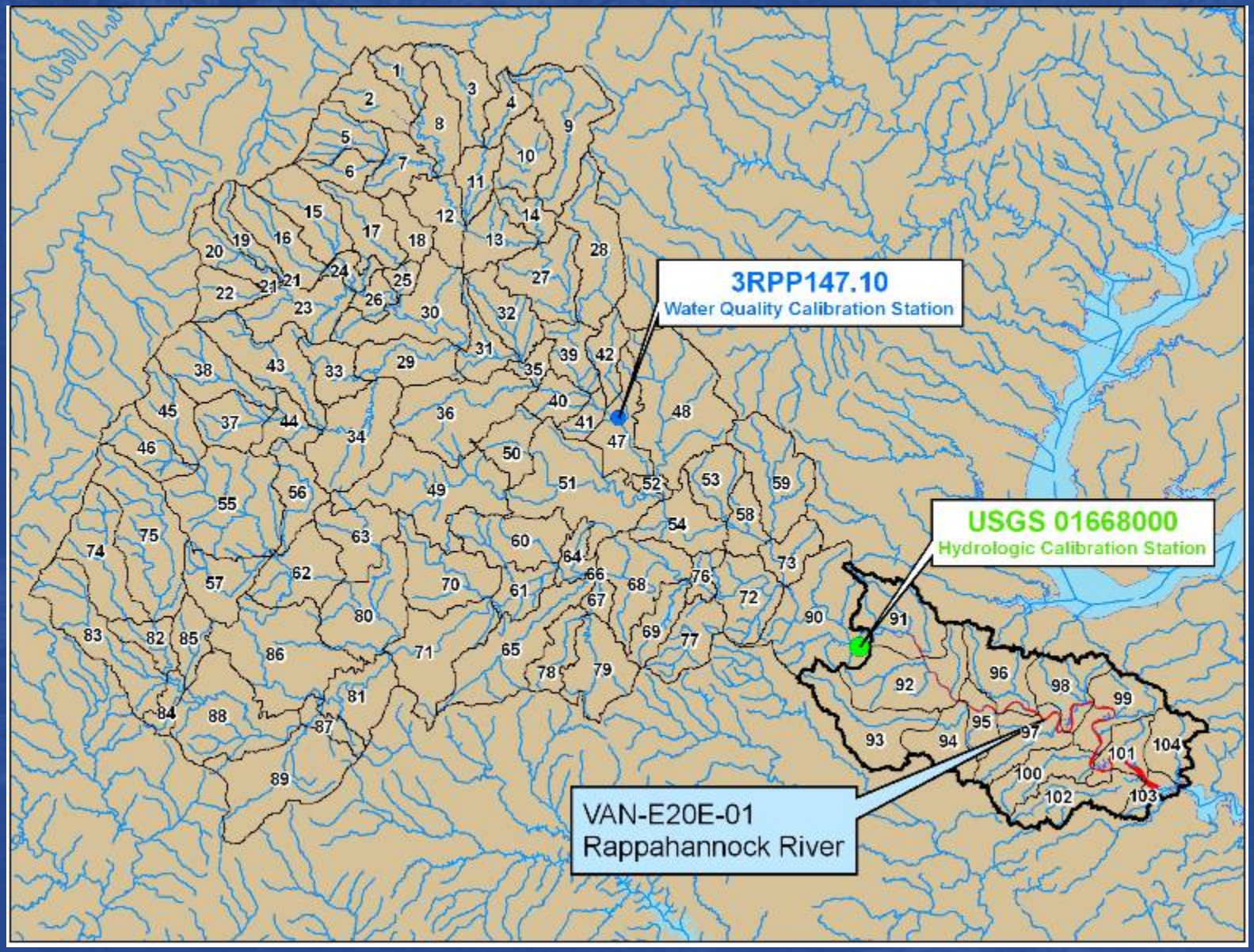
- WASP 7.2
  - The Water Quality Analysis Simulation Program model (Wool et al., 2006) to simulate instream water quality processes for the tidal reaches
- DYNHYD5
  - Dynamic Estuary Hydrodynamics Program (DYNHYD5, a sub-model to WASP7.2), to simulate velocity, volume, and water depth under varying river flow and tides


DYNHYD5
Input
Morphologic Parameters – mean bottom elevations, length and width, mean channel depth
Hydraulic Parameters – mean water surface elevation, roughness coefficient, mean velocity
Upstream Boundary – freshwater flow
Downstream Boundary – tidal heights
Output
Time-variable channel flows, velocities, depths, and volumes
HSPF
Hydrologic Simulation Program - FORTRAN
Input
Meteorological Input Time Series – rainfall, evapotranspiration, temperature, solar radiation
Bacteria Kinetics – build up, wash off, decay
Output
Time series of runoff flow rate and bacteria concentrations
WASP 7.2
Water Quality Analysis Simulation Program
Hydrodynamic Linkage
Nonpoint Source Linkage
Input
Upstream Boundary
Time Series of Bacteria Loads
Output
Bacteria concentration at each tidal segment

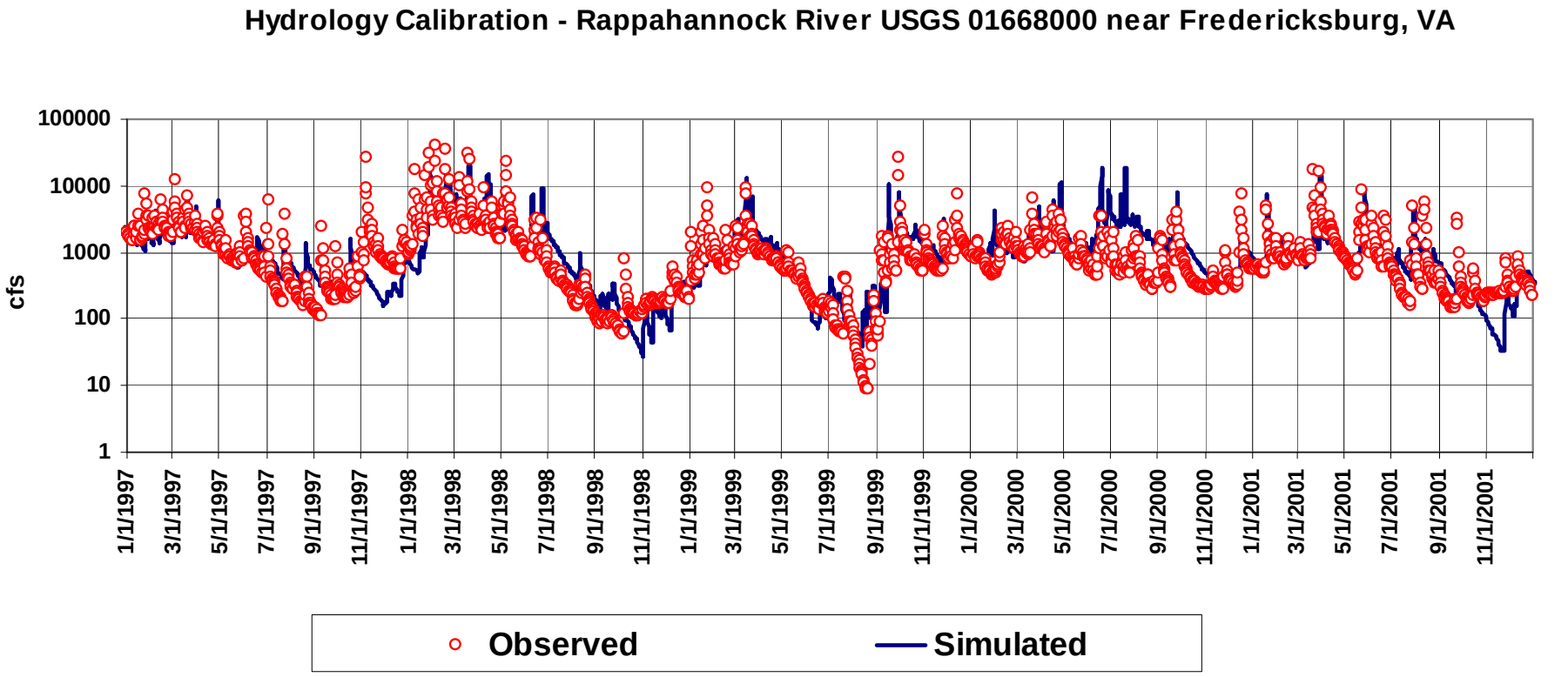
HSPF Model Setup and Calibration

- **Rappahannock River Watershed delineated into 104 model subwatersheds to estimate bacteria loadings to the impaired segment:**
  - From the upper portion of the watershed
  - From the land within the impaired segment
- **Weather data:**
  - NCDC data from Fredericksburg STP and National Airport
- **Hydrologic Model Calibration**
  - USGS Flow Station 01668000
- **Water Quality Calibration**
  - VA DEQ monitoring station 3RPP147.10 (HSPF Segment 47) to estimate the fecal load from the upper Rappahannock River to the tidal segment

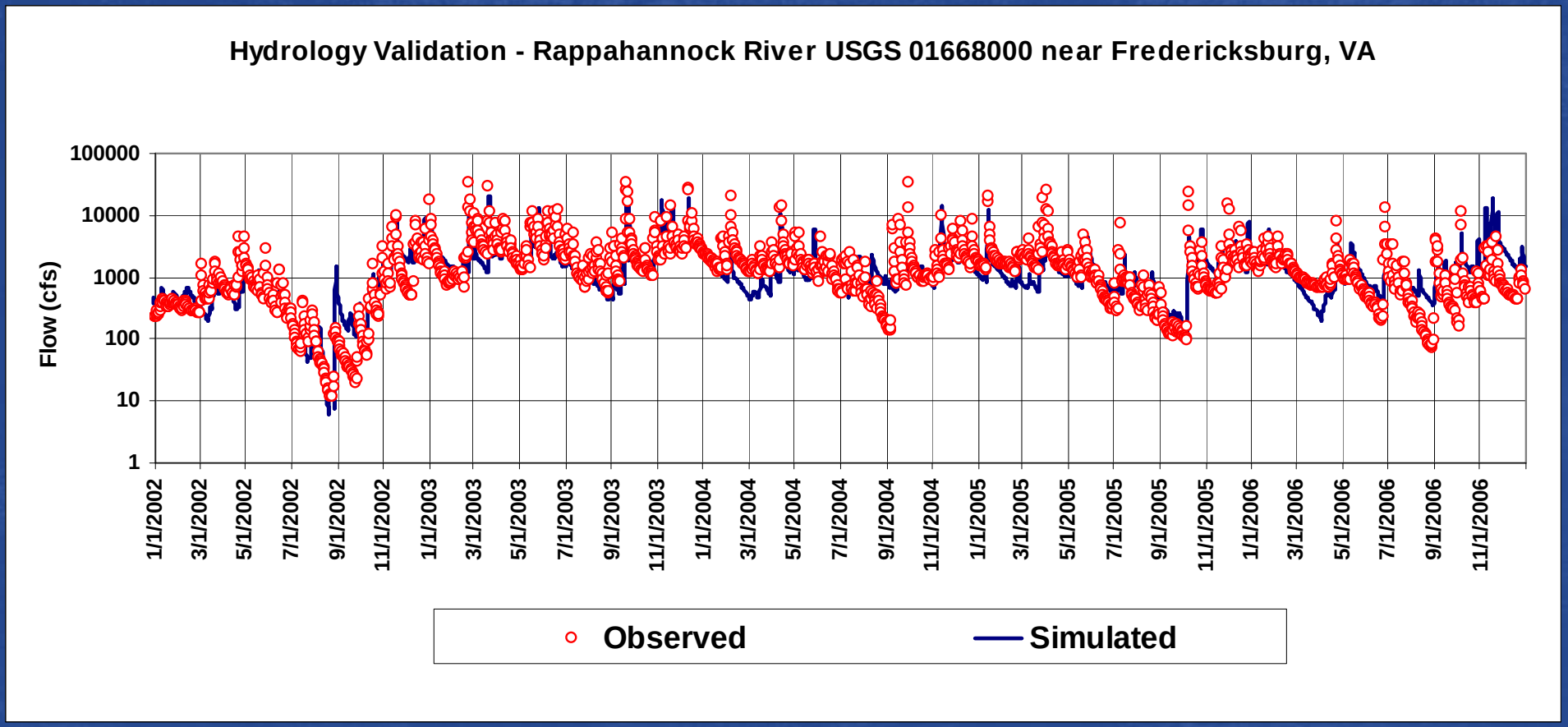
HSPF Model Segmentation



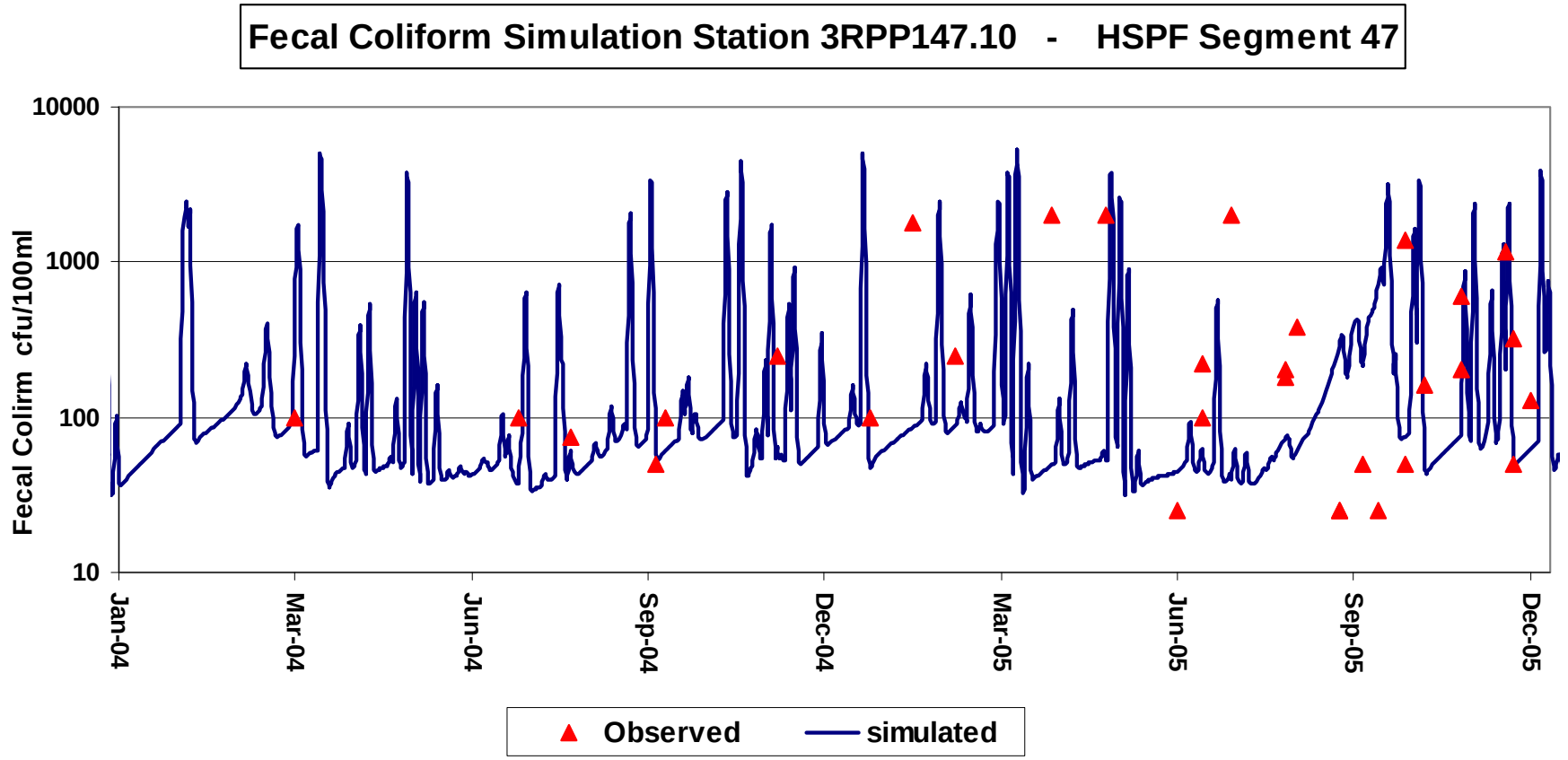
HSPF Hydrology Calibration (1997-2001)



HSPF Hydrology Validation (2002-2006)



HSPF Water Quality Results
Rappahannock River Reach 47 – 3RPP147.10



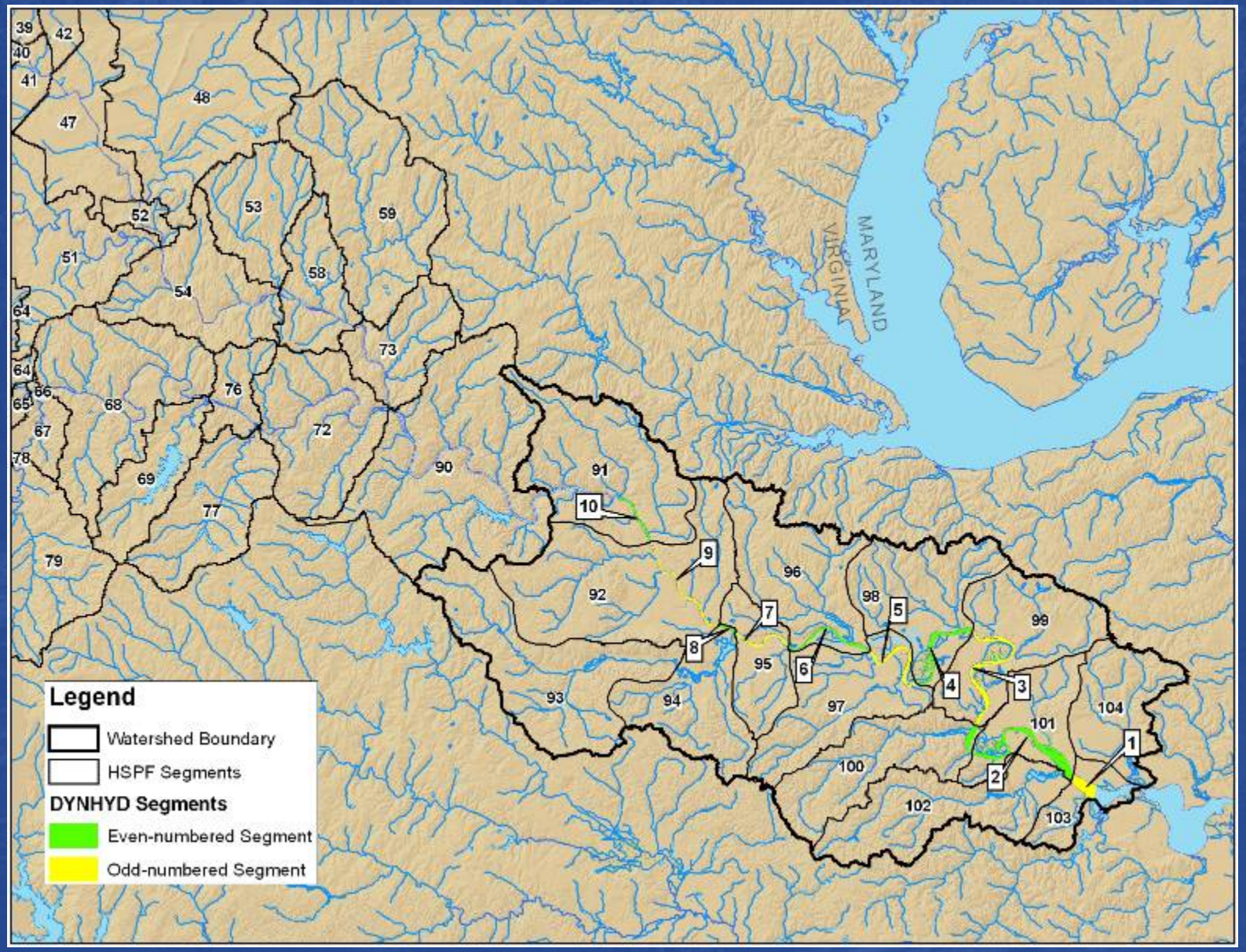
Fecal Coliform Geometric Mean	
Simulated	Observed
103.1	109.5

% Violations Fecal Coliform Instantaneous Standard	
Simulated	Observed
13.8	11.1

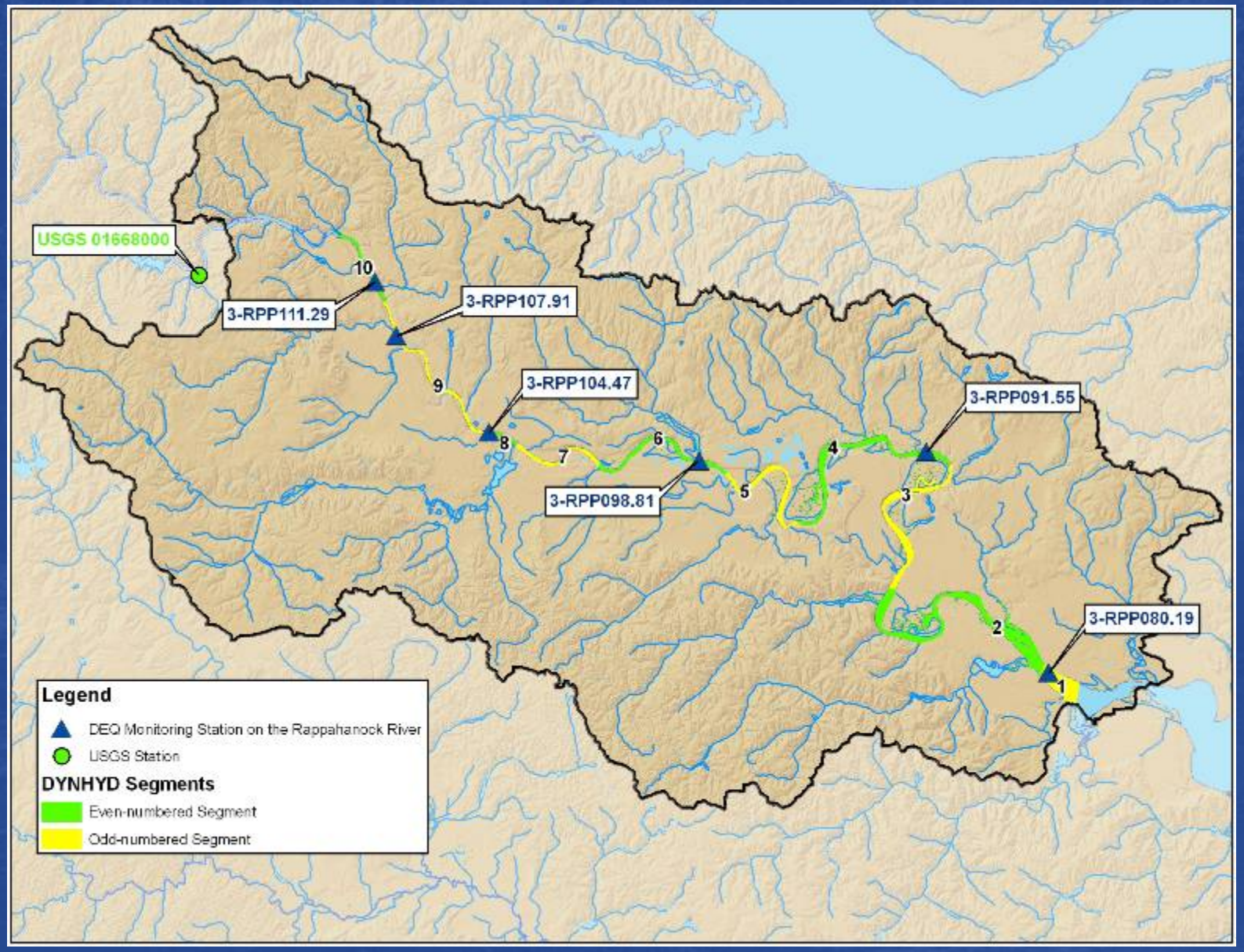
Instream Water Quality Model Implementation

- **10 model segments were defined**
- **Model segments correspond to outlets of HSPF Segments to facilitate the linkage**
- **Hydrodynamic Model (DYNHYD5) driven by:**
  - USGS Flow Station 01668000 for freshwater input
  - NOAA Tide Prediction Tables (Water Heights)
  - NOAA Bathymetry Data
- **Water quality Model (WASP7.2)**
  - DYNHYD5 and WASP7.2 from 1/1/2004 to 12/31/2005
  - Upstream bacteria load, at HSPF segment 90, linked to the headwater of the impaired segment (WASP7.2)
  - HSPF land-based and direct loads linked to WASP7.2
  - Calibration performed using bacteria data at 6 water quality stations located on the impaired segment

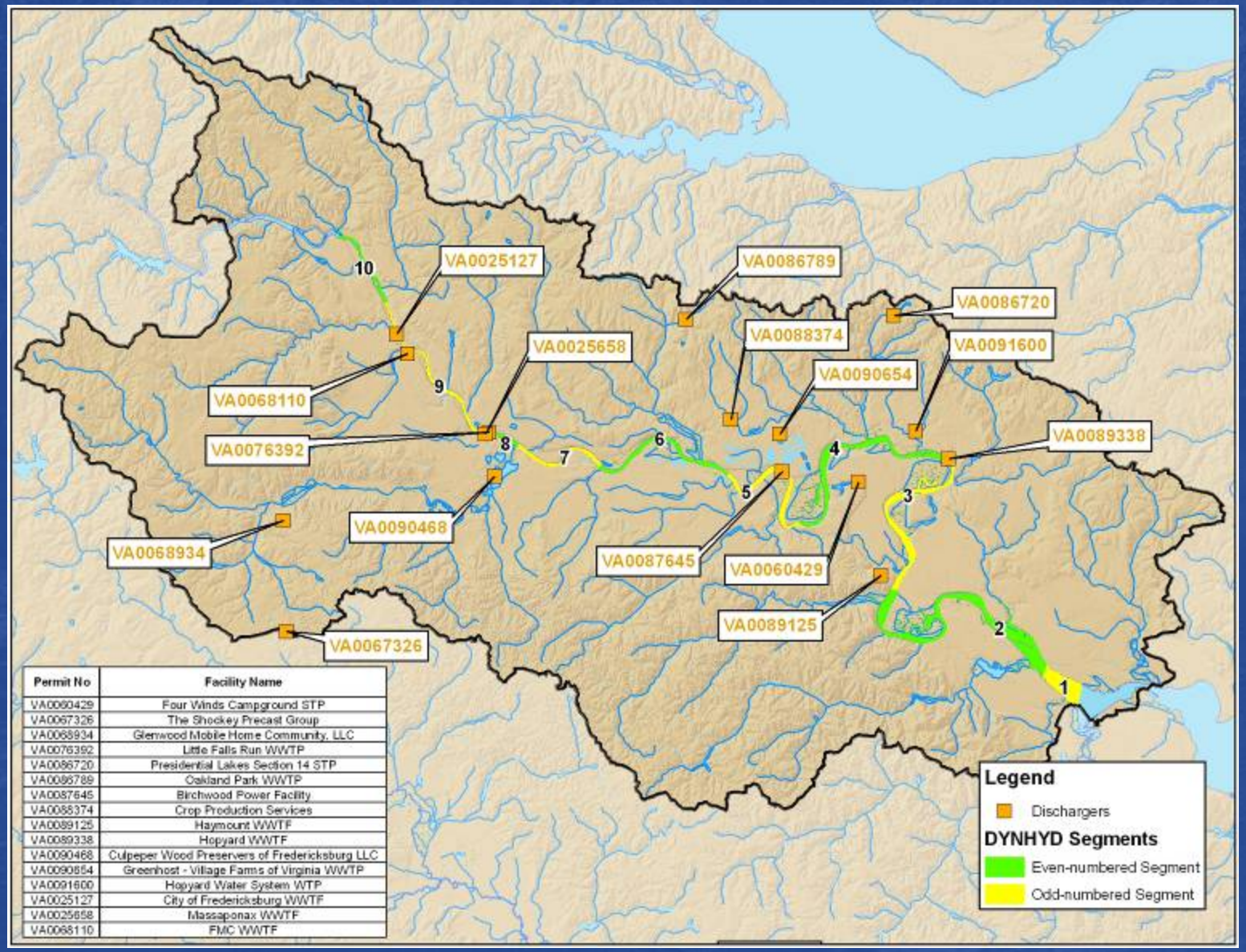
Instream Water Quality Model Implementation



Instream Water Quality Calibration Stations



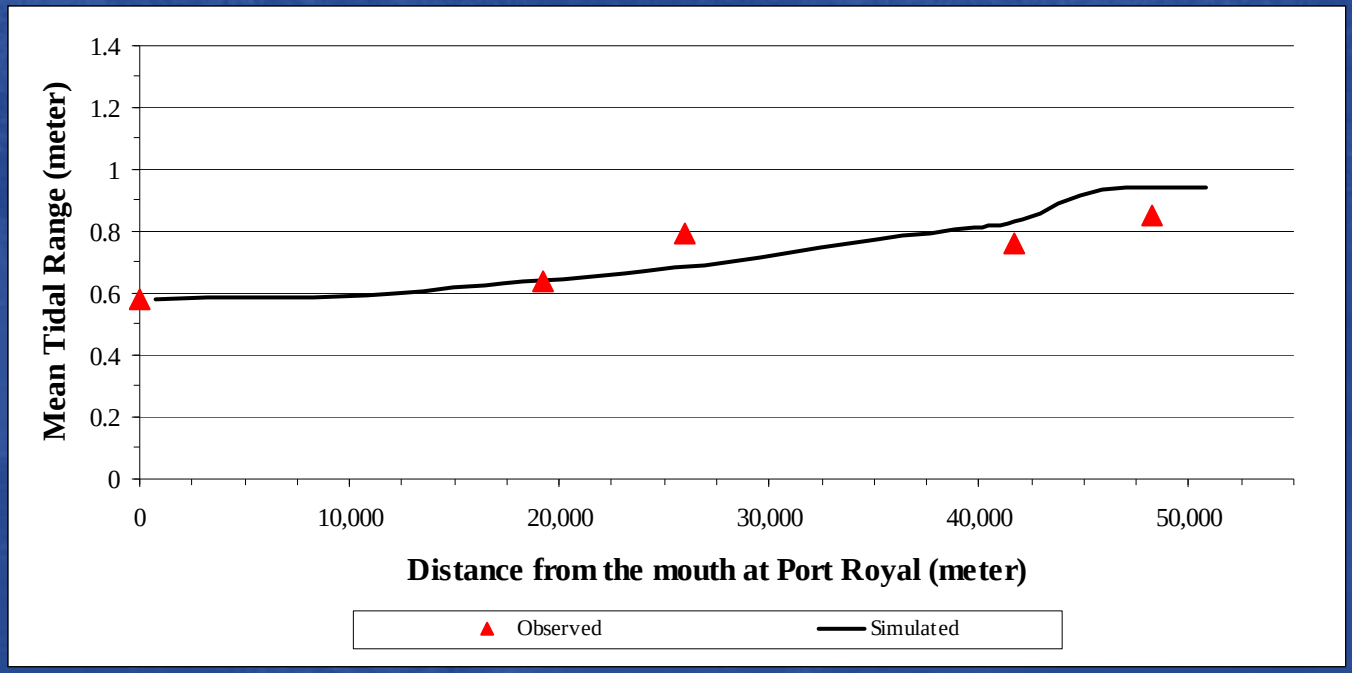
Permitted Dischargers



Permit No	Facility Name
VA0090429	Four Winds Campground STP
VA0067326	The Shockey Precast Group
VA0068934	Glenwood Mobile Home Community, LLC
VA0076392	Little Falls Run WWTP
VA0086720	Presidential Lakes Section 14 STP
VA0086789	Oakland Park WWTP
VA0087645	Birchwood Power Facility
VA0088374	Crop Production Services
VA0089125	Haymount WWTF
VA0089338	Hopyard WWTF
VA0090468	Culpeper Wood Preservers of Fredericksburg LLC
VA0090654	Greenhost - Village Farms of Virginia WWTP
VA0091600	Hopyard Water System WTP
VA0025127	City of Fredericksburg WWTF
VA0025658	Massaponax WWTF
VA0068110	FMC WWTF

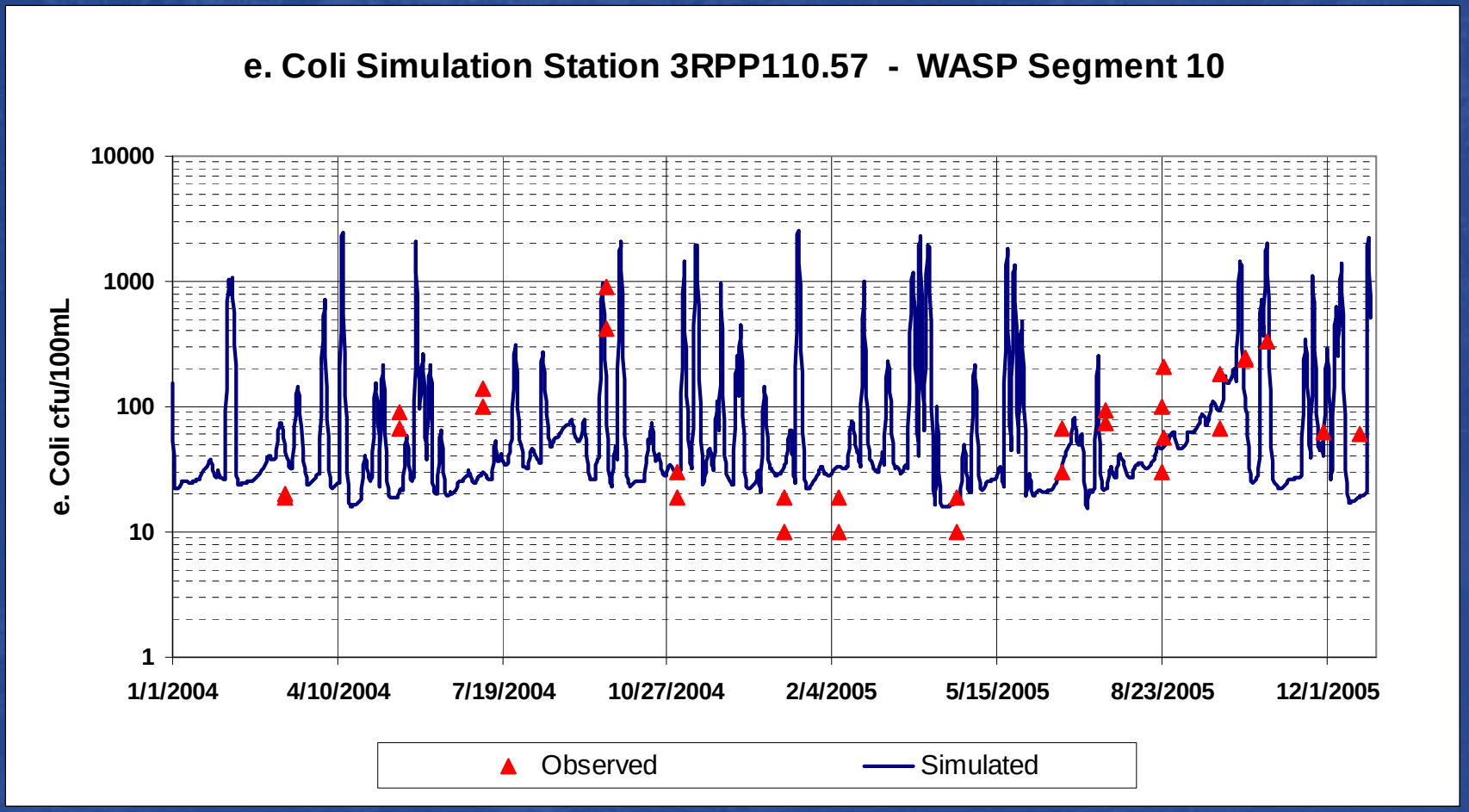
DYNHYD5 Calibration: Mean Tidal Range

NOAA Station	Location in Meters
Port Royal	0.0
Hopyard Landing	19,250
Corbins Neck	26,000
Massaponax	41,710
Fredericksburg	48,280



- Mean Tidal Range: The mean difference between high and low tidal levels
- Observed: based on NOAA long term observation
- Simulated: based on hourly simulation results between 1/1/2004 and 12/31/2005

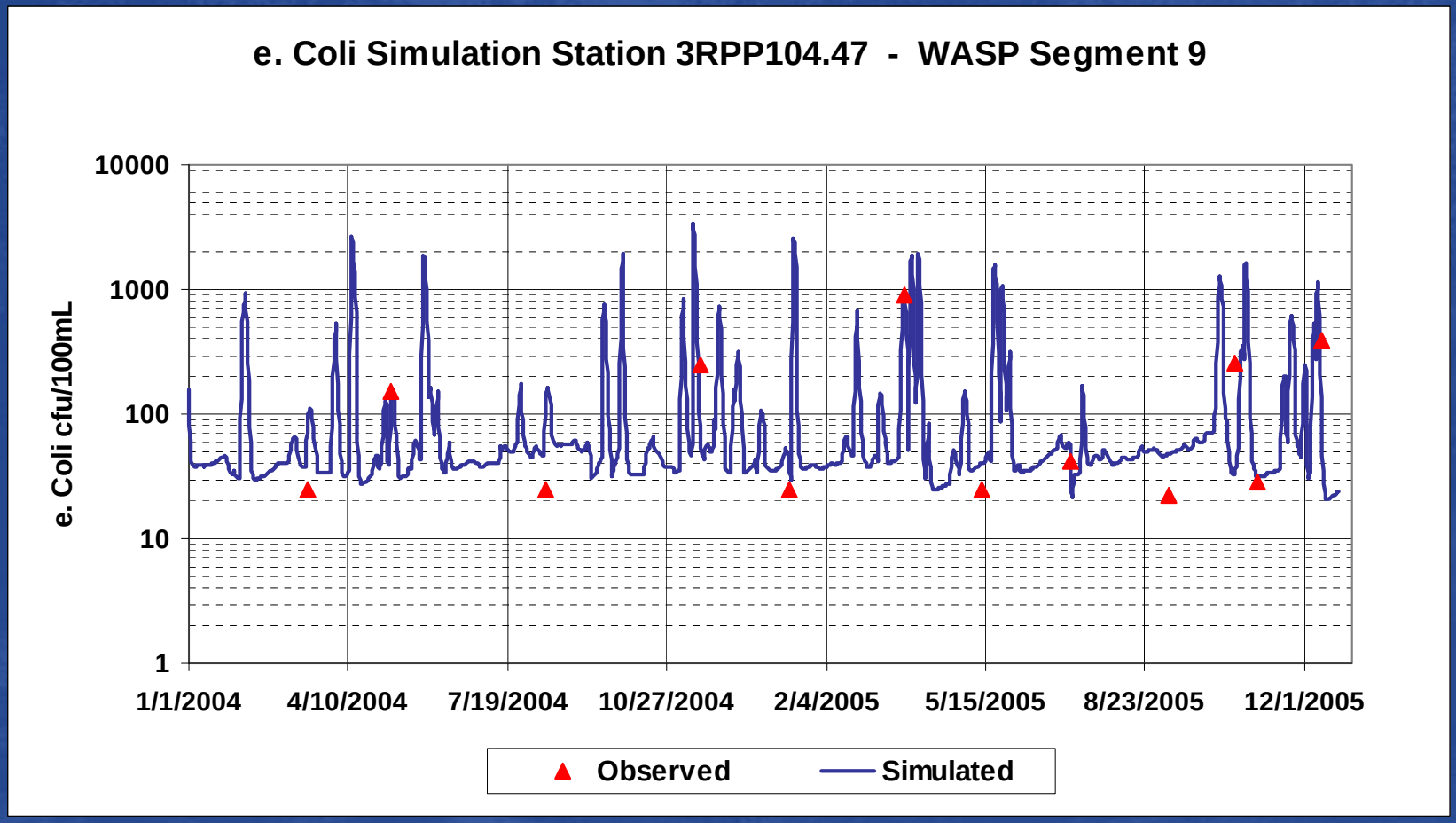
WASP Tidal Rappahannock River – 3RPP110.57



e. Coli Geometric Mean	
Simulated	Observed
53.4	60.9

% Violations e. Coli Instantaneous Standard	
Simulated	Observed
16.1	11.4

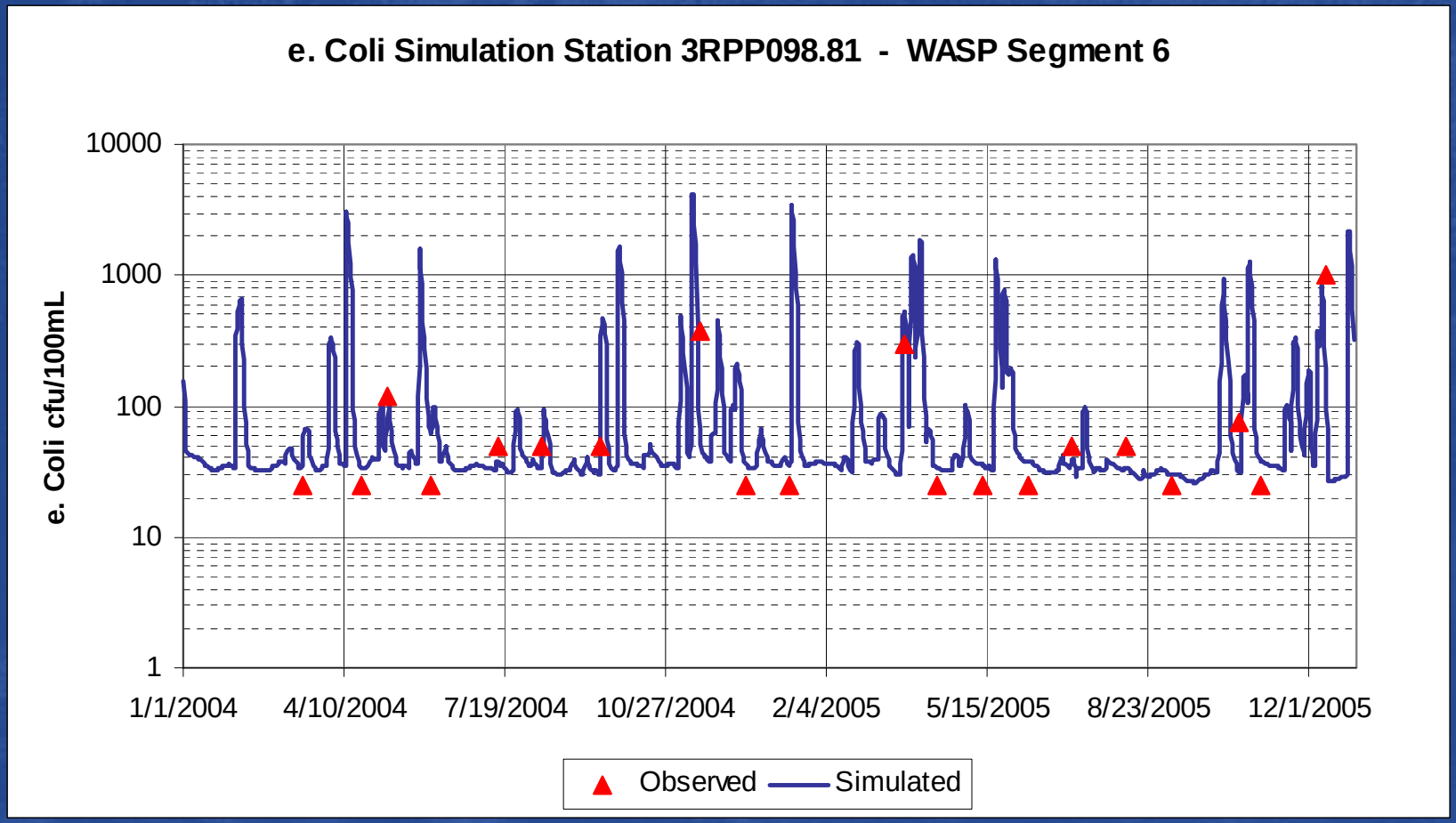
WASP Tidal Rappahannock River – 3RPP104.47



e. Coli Geometric Mean	
Simulated	Observed
64.5	75.4

% Violations e. Coli Instantaneous Standard	
Simulated	Observed
33.3	10.8

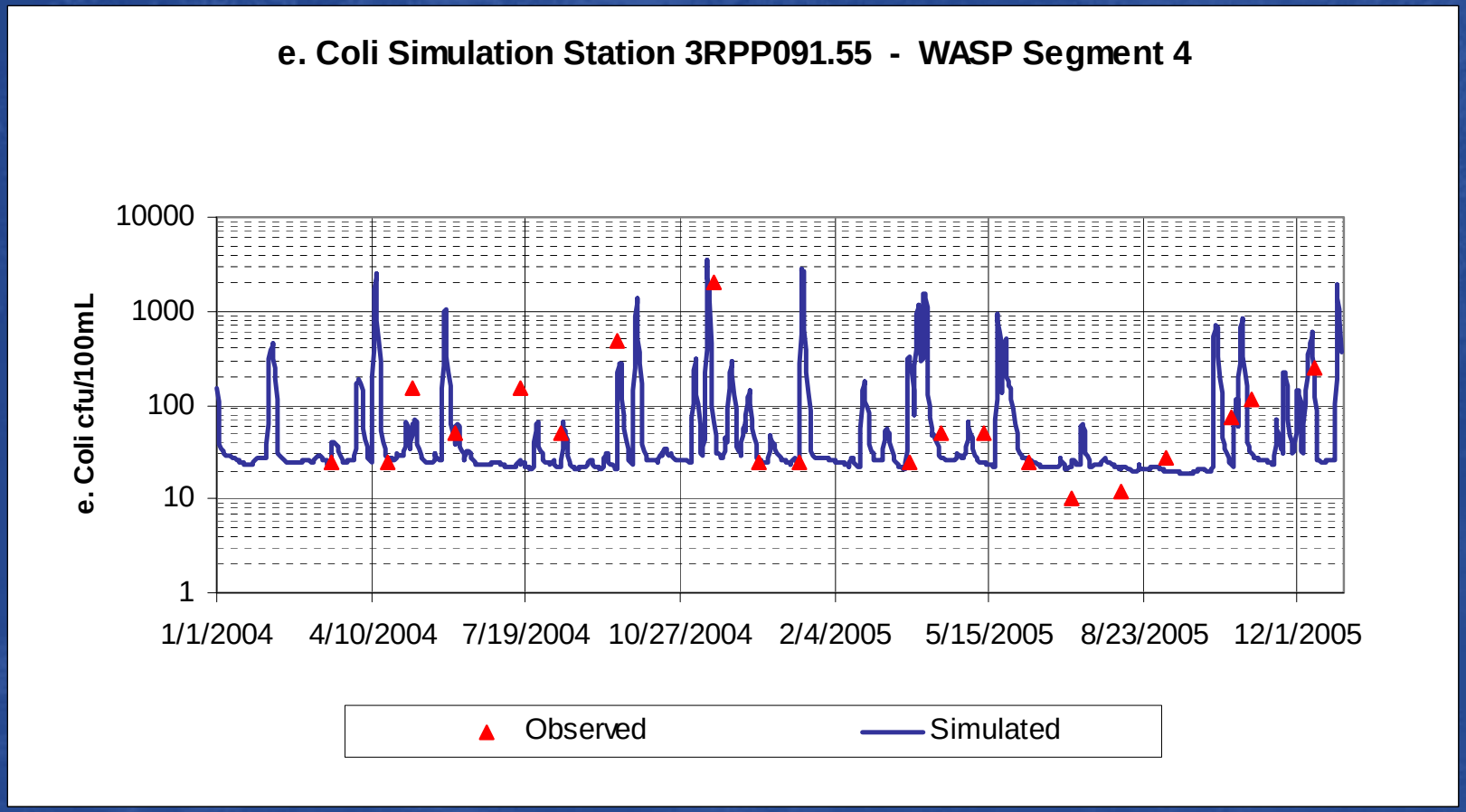
WASP Tidal Rappahannock River – 3RPP098.81



e. Coli Geometric Mean	
Simulated	Observed
55.7	53.0

% Violations e. Coli Instantaneous Standard	
Simulated	Observed
15.0	9.9

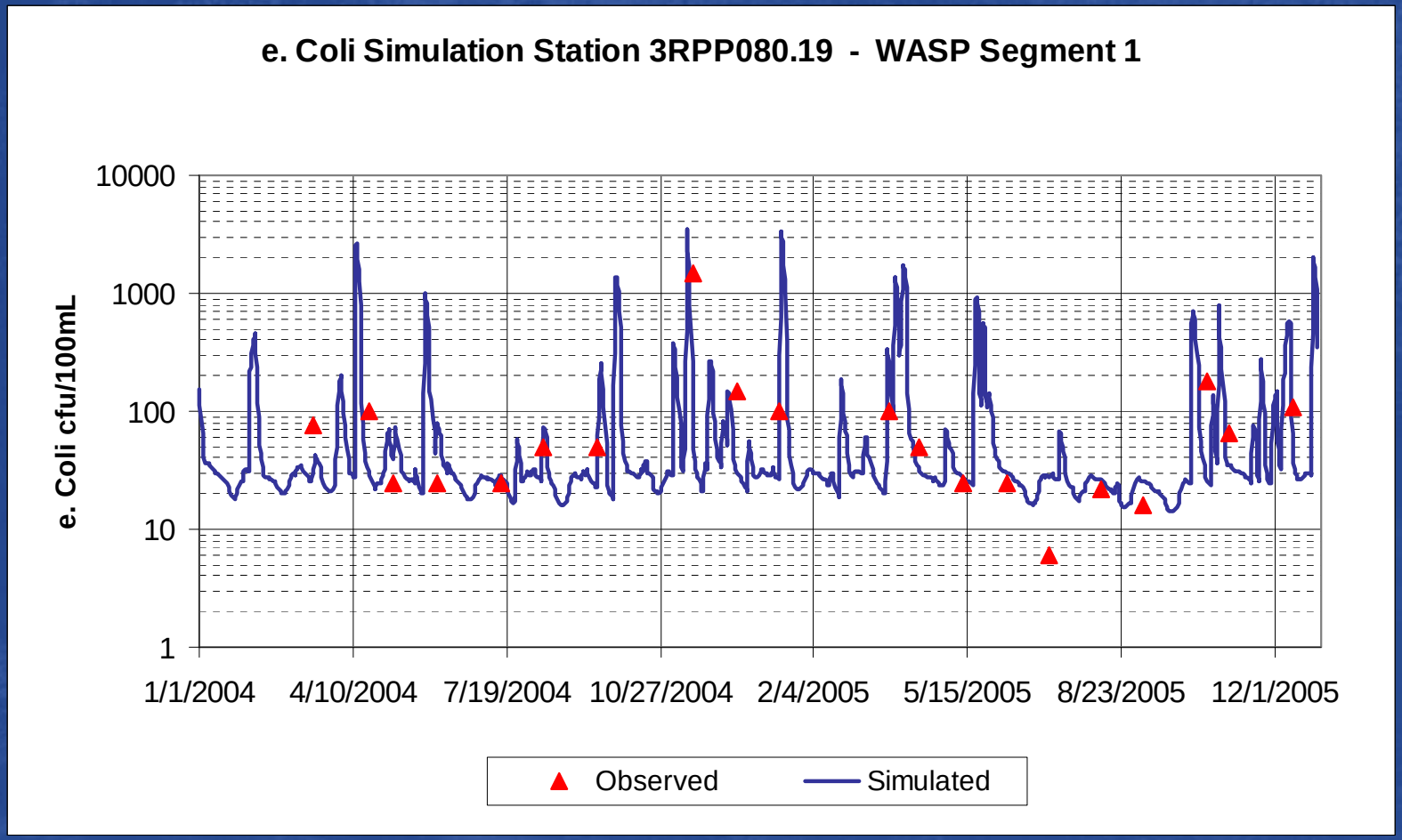
WASP Tidal Rappahannock River – 3RPP091.55



e. Coli Geometric Mean	
Simulated	Observed
40.3	58.6

% Violations e. Coli Instantaneous Standard	
Simulated	Observed
15.0	8.6

WASP Tidal Rappahannock River – 3RPP080.19



e. Coli Geometric Mean	
Simulated	Observed
41.1	54.6

% Violations e. Coli Instantaneous Standard	
Simulated	Observed
5.0	8.5

Allocation Scenarios

1. Estimate the nonpoint and direct loads to each model segment and to the entire impairment
2. Set the bacteria load from the Upper Rappahannock River feeding to the tidal segment at fecal coliform standard
3. Implement Allocation Scenarios
4. Identify fecal coliform reductions by source

Water Quality Standard for Bacteria

Indicator	Status	Instantaneous Maximum (cfu/100mL)	Geometric Mean (cfu/100mL)
Fecal Coliform	Old	1,000	200
E. coli	New	235	126
Fecal Coliform	Interim	400	200

- Changes went into effect on January 15, 2003
- Both new E. coli and Interim Fecal Coliform criteria apply
- Fecal coliform criteria will be phased out entirely once 12 E. coli samples have been collected or after June 30, 2008
- In order for a water body to be listed as impaired:
  - There must be at least two samples that exceed water quality criterion
  - Greater than 10.5% of the total samples must be exceedances

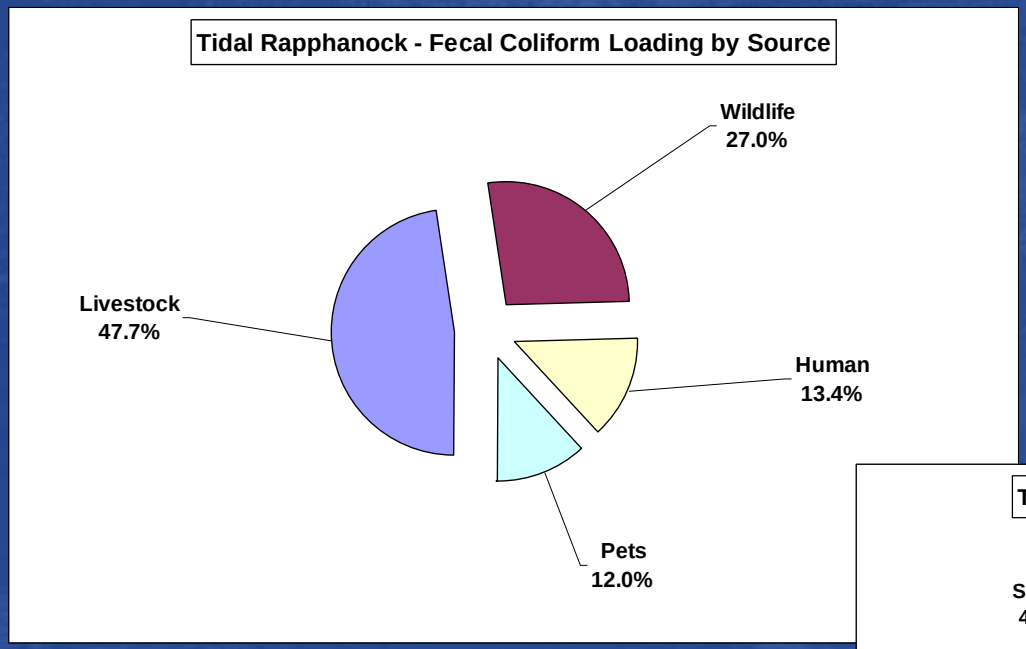
Existing Fecal Coliform Load Distribution by Model Segment

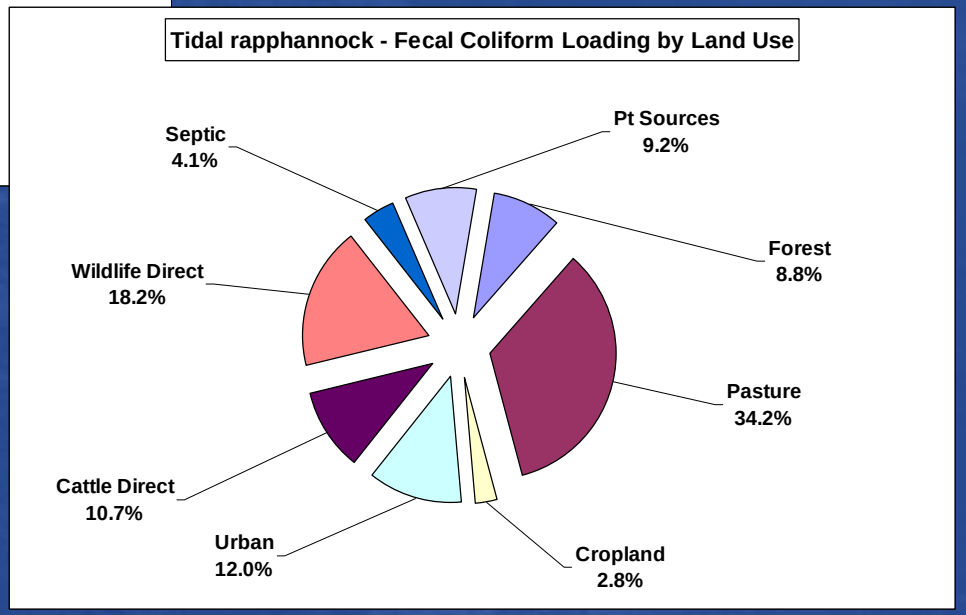
Segment	High Res.	Low Res.	Cropland	Pasture	Forest	Water	Cattle Direct	Wildlife Direct	Septic	Point Sources	Total Load to Segment (cfu/yr)
10	8.8%	11.7%	1.8%	22.9%	6.5%	0.1%	8.6%	23.0%	16.6%	0.0%	4.72E+12
9	10.6%	13.6%	1.3%	24.8%	4.8%	0.1%	6.6%	9.0%	6.5%	22.7%	6.02E+12
8	8.9%	12.5%	2.1%	18.8%	10.3%	0.1%	6.2%	8.4%	6.1%	26.6%	6.44E+12
7	1.3%	2.7%	4.5%	57.1%	9.9%	0.1%	0.0%	23.9%	0.3%	0.0%	1.72E+12
6	3.2%	5.1%	3.0%	50.6%	6.2%	0.1%	10.7%	20.3%	0.4%	0.5%	4.23E+12
5	1.1%	2.0%	4.2%	48.6%	12.4%	0.2%	0.0%	25.9%	0.2%	5.3%	3.10E+12
4	1.4%	2.3%	2.4%	35.5%	6.4%	0.2%	30.4%	16.4%	0.2%	4.8%	4.90E+12
3	1.4%	2.1%	4.0%	49.8%	8.7%	0.2%	8.5%	21.7%	0.2%	3.5%	3.83E+12
2	0.1%	0.2%	3.1%	13.4%	34.5%	0.2%	0.0%	48.4%	0.3%	0.0%	1.56E+12
1	0.8%	1.2%	4.5%	41.4%	6.2%	0.5%	26.5%	18.8%	0.2%	0.0%	2.82E+12
Total											3.94E+13

Existing Fecal Coliform Load Distribution to the Impaired Segment

High Res.	Low Res.	Cropland	Pasture	Forest	Water	Cattle Direct	Wildlife Direct	Septic	Point Sources	Total Load (cfu/yr)
1.96E+12	2.74E+12	1.08E+12	1.34E+13	3.44E+12	5.88E+10	4.21E+12	7.16E+12	1.62E+12	3.63E+12	3.94E+13
5.0%	7.0%	2.8%	34.2%	8.7%	0.1%	10.7%	18.2%	4.1%	9.2%	100.0%

Tidal Rappahannock River
Fecal Coliform Load Distribution





Allocation Scenarios

Scenario	Percent Reductions					Exceedances	
	Failed Septic	Direct Livestock	NPS (Agriculture)	NPS (Urban)	Direct Wildlife	Monthly Geomean	Instantaneous
0 (Existing Condition)	0	0	0	0	0	8.3%	33.3%
1	100	0	0	0	0	12.5%	3.8%
2	100	100	0	0	0	8.3%	3.7%
3	100	100	50	0	0	8.3%	2.9%
4	100	100	50	50	0	4.2%	2.3%
5	100	100	50	95	0	0.0%	0.8%
6	**100**	**100**	**85**	**85**	**0**	**0.0%**	**0.0%**

For Scenarios 1 to 6, the upstream load from the upper Rappahannock River watershed is set at standard.

TMDL Requirements

- **TMDL for the tidal Rappahannock River will require:**
  - 100% reduction of fecal coliform loads from failed Septics
  - 100% reduction of fecal coliform direct loads from cattle
  - 85% reduction of fecal coliform NPS loads from agriculture
  - and 85% reduction of fecal coliform NPS load from urban (pets)

Next Steps

- Finalize Allocations
- Develop TMDLs
- Draft TMDL Report
- Public Comment Period
- Respond to Comments
- Final TMDL Report
- Submit TMDL Report to EPA

Implementation Plans

- Following approval of the TMDL by EPA, an Implementation Plan must be developed.
- Implementation Plans are required by state legislation (*WQMIRA, 1997).
- Outlines plan to link non-point source load reductions specified in TMDL Development Study to corrective actions (e.g., BMPs).

**WQMIRA – Water Quality Monitoring, Information, and Restoration Act.*

Implementation Plans:

- **Must Include *(required under WQMIRA)*:**

  1) List of implementation actions and associated costs, benefits and environmental impact of addressing the impairment.

  2) Measurable goals and milestones and the date of expected achievement of water quality objectives.

- **Need participation from a broad range of individuals, agencies, organizations and businesses who have localized information about the watershed.**

Interested in Doing an Implementation Plan for the Rappahannock River?

- **Gather Support**

  Once the TMDL has been approved, gather support from county governments, soil and water conservation districts, etc. Funding is limited, and usually goes to watersheds with high levels of support from local stakeholders.

- **Contact Virginia Department of Conservation and Recreation (DCR) Staff or DEQ Staff:**

  May Sligh

  Department of Conservation and Recreation

  York/Rappahannock Watershed Field Coordinator

  (804)443-1494

  May.Sligh@dcr.virginia.gov

Comments? Feedback?

- **Public Comment Period for this meeting extends from November 13, 2007 to December 13, 2007.**
- **All comments should be in writing. Please send them to:**

Katie Conaway

Virginia Department of Environmental Quality

13901 Crown Court, Woodbridge, Virginia, 22193

E-mail: mkconaway@deq.virginia.gov

Fax: (703) 583-3841

Local TMDL Contacts

Katie Conaway

TMDL Coordinator

Virginia Department of Environmental Quality

Northern Virginia Regional Office

13901 Crown Court

Woodbridge, VA 22193

mkconaway@deq.virginia.gov

Phone:(703) 583-3804

Fax: (703) 583-3821

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The Louis Berger Group, Inc.

Raed M. EL-Farhan

(202) 331-7775

relfarhan@louisberger.com